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IDENTIFIERS	Bergen County Vocational Technical Schools NJ; *Control Systems (Mechanical)

ABSTRACT

This course is one of four in a solar systems and energy management program developed by the Bergen County Vocational-Technical Schools to help tradespeople (heating, ventilation, and air conditioning; mechanics; plumbers; and electricians) to develop an awareness of alternate energy sources and to gain skills in the areas of solar installations and energy evaluation and management. The format of the course is a combination of lectures, visual presentations, and shop sessions. Upon completion of the course, students will be expected to understand the theory of energy management control, with a concentration in the area of heating and air conditioning. In addition, students will have been exposed to many different types of energy management control systems and will have gained the skills required to install, calibrate, and repair such systems. Following introductory materials that explain the purpose and conduct of the course, the course syllabus contains seven units. Each unit consists of an outline, objectives, note to the instructor, and/or shop session notes. The units cover the following topics: introduction and orientation, orientation to energy management controls, review of mechanical controls, electronics, controls, sensors, and total control systems. The competencies to be acquired by students are listed at the end of the syllabus. (KC)

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BERGEN COUNTY VOCATIONAL-TECHNICAL SCHOOLS
200 Hackensack Avenue
Hackensack, New Jersey 07601

COURSE SYLLABUS

COURSE TITLE:

ENERGY MANAGEMENT CONTROLS

CE038253

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April, 1983

ENERGY TECHNOLOGY DEPARTMENT

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Trade Extension Division
Bergen County Vocational-Technical Schools
200 Hackensack Avenue
Hackensack, New Jersey 07601

COURSE SYLLABUS

COURSE TITLE: ENERGY MANAGEMENT CONTROLS

LENGTH OF COURSE: 60 HOURS

SUGGESTED TEXT:

COURSE DESCRIPTION: The focus of this course is upon equipment which can be utilized to conserve valuable energy sources. Topics include the theory of energy management controls and computers, and the installation, calibration and servicing of energy management control equipment.

OVERVIEW OF THE ADULT ENERGY TECHNOLOGY PROGRAM

The Energy Technology Program for adults consists of technical training courses offered exclusively by the Bergen County Vocational-Technical Schools and a college-credit certificate program offered in conjunction with Bergen Community College.

Technical training courses offered through this school include Heating, Air Conditioning and Refrigeration, Oil Burner Technician Training, Blueprint Reading and Estimating for the HVAC Trades, Sheet Metal Layout and a new program in Solar Systems and Energy Management. In addition to these part-time technical training programs, the School operates a full-time, intensive training program for HVAC mechanics.

The new solar program is designed for tradespeople (HVAC mechanics, plumbers, electricians) to help them develop an awareness of alternate energy sources such as solar and to gain skills in the areas of solar installations and energy evaluation and management.

INTRODUCTION TO COURSE

The purpose of this course is to train students to install and service the types of energy management control systems that are in service in industrial and commercial buildings today.

The requirements for entrance into this course include completion of "Introduction to Air Conditioning" and "Commercial" or "Residential Air Conditioning". A High School diploma is desirable.

Upon completion of the course, the student will have developed the technical capability needed to understand the theory of energy management control, with a concentration in the area of heating and air conditioning. In addition, the student will have been exposed to many different types of energy management control systems and will have gained the skills required to install, calibrate and repair such systems.

INSTRUCTIONAL METHODS

A combination of instructional methods will be utilized. Lecture will be supplemented by demonstrations, teacher-prepared handouts and visual aids, including slides, 16mm film and/or overhead projections as may be appropriate to the instructional unit. "Hands-on" shop sessions are designed to reinforce theory, to provide students with job-simulated experiences, and to expose students to equipment utilized in the field.

CLASS REQUIREMENTS

Students will be expected to come prepared for class by completing reading and other homework assignments. Students will be expected to take notes in class and to study in a manner conducive to successful performance on tests and quizzes.

STUDENT EVALUATION AND GRADING

The exact procedure for grading will be the decision of the individual instructor; however, the following guidelines will be adhered to:

1. A written midterm and final examination covering all material presented in the course will be administered and evaluated.
2. An average of six quizzes will be administered and evaluated periodically during the course.
3. Shop/laboratory exercises will be evaluated.
4. Attendance and attitude will be evaluated.
5. Final grade will reflect the aggregated evaluation of the above.

UNIT I: INTRODUCTION AND ORIENTATION

Unit Outline:

A. Overview of the Adult Energy Technology Program
B. Introduction to Course
    1. Description and purpose of course
    2. Pre-requisite requirements
    3. Projected outcomes for students who successfully complete course
        a. Anticipated learning
        b. Job preparation
    4. Class requirements
    5. Instructional methods
    6. Student evaluation and grading policy
C. Safety Regulations (as per district policy)
    1. Proper use of shop equipment
    2. Safety goggles
    3. Clothing
    4. Body mechanics
    5. Emergency procedures in case of accident
D. Fire Information
    1. Fire extinguishers
    2. Fire drills and safe exit from building
E. Smoking Policy
F. General Information for Students
        a. Parking
        b. Book purchase
        c. Breaks
        d. Class cancellation
        e. Certificate of course completion

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Develop an overview of the adult Energy Technology program.

2. Develop a clear understanding of the course, including its purpose, requirements for entrance, projected outcomes, class requirements, methods of instruction, evaluation and grading.

3. Explain and demonstrate safe use of shop equipment.

4. Explain when and why safety goggles are to be utilized.

5. Identify acceptable and unacceptable clothing as related to shop safety.

6. Define the term "body mechanics."

7. Describe the benefits of using good body mechanics in the shop and demonstrate same.

8. Explain the procedure to be followed in case of accident.

9. Identify any combustible materials in the shop and select the proper extinguishing agent(s).

10. Explain the color and letter markings on various fire extinguishers.

11. Demonstrate the proper handling and safety precautions to be used with extinguishers.

12. Demonstrate the fire emergency procedure of the school.

13. Identify the smoking regulations of the school.

14. Review school policy in terms of parking, class breaks, purchase of books, cancellation of class, and certificate requirements upon completion of course.

NOTE TO INSTRUCTOR:

Consult the district Safety Education Program manual (Fall, 1981) for policy and practice relative to general safety regulations, fire information, and smoking policy.

UNIT II: ORIENTATION TO ENERGY MANAGEMENT CONTROLS

Unit Outline:

A. Objectives of Energy Resource Management
    1. Lower energy consumption
    2. Lower electrical demand
    3. Utilization of inexpensive fuels
B. Comparison of fuel costs
    1. Oil
    2. Natural and propane gas
    3. Electricity
    4. Solar energy
C. Life cycle cost of power utilization units
    1. Installation
    2. Maintenance
    3. Repair
    4. Fuel

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Demonstrate understanding of the objectives of energy management including energy conservation, lowering of electrical demand, and utilization of low cost fuels.

2. Identify the types of fuels now available and how each performs in a energy utilization unit.

3. Provide and explain the cost breakdown for an energy utilization unit, including installation costs, maintenance, repairs, and fuel bills.

UNIT III: REVIEW OF MECHANICAL CONTROLS

Unit Outline:

A. Sensors
    1. Thermostats
    2. Temperature controllers
    3. Humidistats
B. Controllers
    1. Relays
    2. Contactors
    3. Motor Starters
C. Control Devices
    1. Motors
    2. Damper actuators
    3. Valve actuators
    4. Solenoids

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Name the various types of sensors used in the many heating and air conditioning systems.

2. Understand the types of controllers used and describe how each functions in a given system.

3. List various types of control devices and explain how each uses energy to perform a function.

Unit Shop Session:

Students will identify sensors, controllers and control devices that are in operation in a given system. In addition, students will practice the troubleshooting and replacement of defective components.

UNIT IV: ELECTRONICS

Unit Outline:

A. Electron Theory
    1. D.C. Current
    2. Conductors and Insulators
    3. Classification of electricity
B. Ohm's Law
    1. Types of circuits
C. Magnets
    1. Magnetic fields
    2. Generator Theory
    3. Transformer Theory
    4. Relays and Contactors
D. A.C. Circuits
    1. Inductance
    2. Capacitance
    3. Current
    4. Voltage
E. Electrical Meters
    1. Ammeter
    2. Voltmeter
    3. Ohmeter
F. Schematic Drawings
    1. Symbols
    2. Layout
    3. Ladder Diagrams
    4. Reading of Diagrams
G. Motors
    1. D.C. and A.C. Motors
    2. Shaded Pole
    3. Capacitor start
    4. Split phase
    5. Capacitor start, capacitor run
    6. Permanent split capacitor
H. Electrical Wiring
    1. Wiring size
    2. Fuses and Breakers
    3. Electrical piping
    4. Distribution systems
    5. Codes

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Understand the theory of electrons, protons, and neutrons; direct current; and how conductors and insulators are rated and used.

2. Explain how Ohm's Law relates to current, voltage and resistance in a circuit.

3. Discuss how magnetic force is used in generators, transformers and electro-mechanical relays.

4. Outline A.C. Circuit Theory as it relates to inductance, capacitance, voltage, current and resistance.

5. Use electrical meters to identify voltage, amperage, and resistance.

6. Draw/read a schematic diagram using proper symbols and layout.

7. Identify the many types of motors and be able to repair them.

8. Describe the proper way to install wiring, electrical piping, fuses and circuit breakers according to standard codes.

Unit Shop Sessions:

A. Using electrical meters, students will identify types of resistance, voltages and amperage.

B. Students will draw a schematic diagram for a multi-stage, heating and cooling air conditioning unit.

C. Using live motors, students will make diagnoses concerning motor condition. In addition, students will review through practice the procedures for connecting wiring and setting up electrical piping.

UNIT V: CONTROLS

Unit Outline:

A. Purpose and Definition of Terms
B. Relay switching
    1. Electromechanical relays
    2. Electronic switching
    3. Contactors and starters
C. Control circuits
    1. Series
    2. Parallel
    3. Lock-in, lock-out
    4. Multiple control point of switching
D. Control transformers
    1. Operation
    2. Dry Type
    3. Wet Type
E. Solid State
    1. Circuits; how they operate
    2. Semiconductors
    3. Diodes
    4. Transistors
    5. Resistors
    6. Silicon controlled rectifiers
    7. Bridge circuits

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Describe the purpose of controls and define various related terminology.

2. Demonstrate understanding of the different types of relay switching and how each is used in a control system.

3. Differentiate between series, parallels, and lock-in-lock out circuits; in addition, to demonstrate understanding of multiple control point-of-switching in a system.

4. Identify the major types of transformers and explain how each operates.

5. Demonstrate understanding of the operation of solid state circuits and the functions of the following components: diodes, transistors, resistors, silicon controlled rectifiers, and bridle circuits.

Unit Shop Session:

Students will build a miniature low voltage control circuit and will practice troubleshooting solid state components.

UNIT VI: SENSORS

Unit Outline:

A. Thermostats
    1. Theory of operation
    2. Programmable types
    3. Set back/set-up
    4. Installation
    5. Repair
B. Transducers
    1. Operation
    2. Thermistors
    3. Wiring
    4. Calibration
C. Enthalpy Controllers
    1. Operation
    2. Calibration
    3. Repair
D. Humidistats
    1. Types
    2. Installation
    3. Troubleshooting

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Relate the theory of operation for different types of thermostats, as well as the procedures for installation and repair.

2. Explain how a transducer and a thermistor work together in a solid state system to control temperature.

3. Describe how an enthalpy controller operates and demonstrate ability to calibrate and repair one.

4. List the types of humidistats available for various applications and be able to install and service them.

Unit Shop Session:

Students will set-up and operate a programmable thermostat , and practice troubleshooting and repairing transducers, humidistats and enthalpy controllers. Students will also execute a basic design of sensors for a special control system application.

UNIT VII: TOTAL CONTROL SYSTEMS

Unit Outline:

A. Economizers
    1. Theory of operation
    2. Installation procedures
    3. Logic Panels
    4. Control accessories
    5. Troubleshooting
B. Multizone Systems
    1. Load Analyzer
    2. Hot and cold deck control
    3. Zone sensors
    4. Installation
    5. Troubleshooting
C. Load Control
    1. Duty cycling
    2. Load shedding
    3. Computer monitoring
    4. Troubleshooting
D. Power Line Carrier Systems
    1. Radio frequency
    2. Multiplexers
    3. Transmitters
    4. Receiver Relay
    5. Repeaters
    6. Troubleshooting
E. Variable Air Volume Systems
    1. Microprocessor control
    2. Stage sequencing
    3. Air Modulation
    4. Heat/Cool Cycling
    5. Troubleshooting
F. Boiler Reset System
    1. Set-up and calibration (proportional control)
    2. Troubleshooting
G. Computer Monitoring and Control
    1. Programming
    2. Disk Memory
    3. Data Recall
    4. Communication Module
    5. Remote Temperature Control
    6. Remote Energy Monitoring
    7. Remote Troubleshooting
    8. System Check-out and troubleshooting

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Demonstrate an understanding of an economizer system and procedures for installation and troubleshooting of a complete system.

2. Troubleshoot a solid state multizone system with at least (6) zones; recalibrate the system.

3. Program either a duty cycling or load shedding control system; demonstrate ability to monitor the system's functions.

4. Install a power line carrier system with a multiplexer, transmitter, receiver relays and repeaters; repair a malfunctioning system.

5. Explain the functions of a variable air volume system and how each component operates to make up a complete system.

6. Describe a typical boiler reset system and explain how it will cut fuel costs; demonstrate understanding of calibration and repair procedures for such a system.

7. Program a computer to monitor energy usage and control space temperature; demonstrate ability to recall data and change temperature set points of H.V.A.C. systems at remote locations.

Unit Shop Session:

Students will practice troubleshooting techniques on live systems and control systems trainers which have been designed with built-in problems that require diagnoisis and analysis; students will restore systems to proper function.

COURSE PROFICIENCIES

Note: Proficiencies (sometimes referred to as "tasks or "competencies" in the field of education) are defined as those skills acquired by a student that make he or she employable in a vocational or technical trade. Proficiencies are interpreted to mean applied, practical knowledge, i.e., those skills for which an employer would be willing to pay wages. While unit objectives may reflect learning theory as well as practical skills, the proficiencies refer exclusively to salable skills.

Students who complete this course are expected to achieve the following proficiencies:

1. Work safely in a simulated work environment by consistently demonstrating proper safety measures with regard for themselves, for other people, and for equipment and tools.

2. Explain the need for energy management systems and fully enumerate the costs of using a given energy consuming system.

3. List the types of components necessary to operate an energy management system, explain how each works, and describe how to repair each.

4. Demonstrate understanding of electrical theory and the operation of electronic components including transisters, resistors, and diodes.

5. Design a modification for a H.V.A.C. system that improves efficiency by using energy management controls.

6. Troubleshoot the various sensors and controls that are installed in control systems and identify defects.

7. Set-up and calibrate energy management style thermostats which will conserve energy for a H.V.A.C. system.

8. Program a duty cycling control, load shedding control, computer, or programmable thermostat.

9. Install a economizer system in a H.V.A.C. system and calibrate the system to conserve energy.

10. Troubleshoot any energy management system that is found in the field today; make the repairs necessary to restore the system to proper function.